IN THE SPECIFICATION

Please amend the paragraph at page 1, lines 6-12 as follows:

The present application is a continuation of co-pending U.S. Application No. 09/230,109 filed July 8, 1999 (now U.S. 6,236,365) which is the National Stage of International Application No. PCT/US97/15933 filed September 8, 1997 (and claims the benefit thereof) which, in turn, claims the benefit of the following three applications: U.S. Provisional Application No. 60/056,603 filed August 20, 1997, U.S. Provisional Application No. 60/044,821 filed April 25, 1997; and U.S. Provisional Application No. 60/025,855 filed September 9, 1996. All the above cited references are fully incorporated by reference herein.

Please amend the paragraph beginning at page 1, line 18 and ending on page 2, line 19 as follows:

Wireless communications systems are becoming increasingly important worldwide. Wireless cellular telecommunications systems are rapidly replacing conventional wire-based telecommunications systems in many applications. Commercial mobile radio service provider networks, and specialized mobile radio and mobile data radio networks are examples. The general principles of wireless cellular telephony have been described variously, for example in U. S. Patent 5,295,180 to Vendetti, et al filed April 8, 1992, which is incorporated herein by reference. There is great interest in using existing infrastructures for wireless communication systems for locating people and/or objects in a cost-effective manner. Such a capability would be invaluable in a variety of situations, especially in emergency or crime situations. Due to the substantial benefits of such a location system, several attempts have been made to design and implement such a system. Systems have been proposed that rely upon signal strength and trilateralization techniques to permit location include those disclosed in U.S. Patents 4,818,998 filed March 31, 1986 and 4,908,629 filed December 5, 1988 both to Apsell et al. ("the Apsell patents"), which are incorporated fully herein by reference, and 4,891,650 to Sheffer ("the Sheffer patent") filed May 16, 1988 and also incorporated fully by reference. The Apsell patents disclose a system employing a "homing-in" scheme using radio signal strength, wherein the scheme detects radio signal strength transmitted from an unknown location. This signal strength is detected by nearby tracking vehicles, such as police cruisers using receivers with directional

antennas. Alternatively, the Sheffer patent discloses a system using the FM analog cellular network. This system includes a mobile transmitter located on a vehicle to be located. The transmitter transmits an alarm signal upon activation to detectors located at base stations of the cellular network. These detectors receive the transmitted signal and transmit, to a central station, data indicating the signal strength of the received signal and the identity of the base stations receiving the signal. This data is processed to determine the distance between the vehicle and each of the base stations and, through trilateralization, the vehicle's position. However, these systems have drawbacks that include high expense in that special purpose electronics are required. Furthermore, the systems are generally only effective in line-of-sight conditions, such as rural settings. Radio wave surface reflections, refractions and ground clutter cause significant distortion, in determining the location of a signal source in most geographical areas that are more than sparsely populated. Moreover, these drawbacks are particularly exacerbated in dense urban canyon (city) areas, where errors and/or conflicts in location measurements can result in substantial inaccuracies.

Please amend the paragraph at page 4, lines 7-16 as follows:

Actual data collected in real-world environments uncovered huge variations with respect to the free space path loss equation, giving rise to the creation of many empirical formulas for radio signal coverage prediction. Clutter, either fixed or stationary in geometric relation to the propagation of the radio signals, causes a shadow effect of blocking that perturbs the free space loss effect. Perhaps the best known model set that characterizes the average path loss is Hata's, "Empirical Formula for Propagation Loss in Land Mobile Radio", M. Hata, *IEEE Transactions* VT-29, pp. 317-325, August 1980, three pathloss models, based on Okumura's measurements in and around Tokyo, "Field Strength and its Variability in VHF and UHF Land Mobile Service", Y. Okumura, et al, *Review of the Electrical Communications laboratory,* Vol 16, pp 825-873, Sept. - Oct. 1968 <u>these references being incorporated fully herein by reference</u>.

Please amend the paragraph beginning at page 4, line 22 and ending at page 5, line 1 as follows:

In 1991, U.S. Patent 5,055,851 to Sheffer filed November 29, 1989 <u>(and incorporated</u>

herein by reference) taught that if three or more relationships have been established in a triangular space of three or more base stations (BSs) with a location database constructed having data related to possible mobile station (MS) locations, then arculation calculations may be performed, which use three distinct P_{or} measurements to determine an X,Y, two dimensional location, which can then be projected onto an area map. The triangulation calculation is based on the fact that the approximate distance of the mobile station (MS) from any base station (BS) cell can be calculated based on the received signal strength. Sheffer acknowledges that terrain variations affect accuracy, although as noted above, Sheffer's disclosure does not account for a sufficient number of variables, such as fixed and variable location shadow fading, which are typical in dense urban areas with moving traffic.

Please amend the paragraph beginning at page 5, line 28 and ending at page 6, line 13 as follows:

Work by Greenstein has since developed from the perspective of measurement-based regression models, as opposed to the previous approach of predicting-first, then performing measurement comparisons. Apparently yielding to the fact that low-power, low antenna (e.g., 12-25 feet above ground) height PCS microcell coverage was insufficient in urban buildings, Greenstein, et al, authored "Performance Evaluations for Urban Line-of-sight Microcells Using a Multi-ray Propagation Model", in IEEE Globecom Proceedings, 12/91, incorporated fully by reference. This paper proposed the idea of formulating regressions based on field measurements using small PCS microcells in a lineal microcell geometry (i.e., geometries in which there is always a line-of-sight path between a subscriber's mobile and its current microsite). Additionally, Greenstein studied the communication channels variable Bit-Error-Rate (BER) in a spatial domain, which was a departure from previous research that limited field measurements to the RF propagation channel signal strength alone. However, Greenstein based his finding on two suspicious assumptions: 1) he assumed that distance correlation estimates were identical for uplink and downlink transmission paths; and 2) modulation techniques would be transparent in terms of improved distance correlation conclusions. Although some data held very correlation, other data and environments produced poor results. Accordingly, his results appear unreliable for use in general location context.

Please amend the paragraph beginning at page 6, line 29 and ending at page 7, line 3 as

follows:

At Telesis Technology in 1994 Howard Xia, et al, authored "Microcellular Propagation Characteristics for Personal Communications in Urban and Suburban Environments", in IEEE Transactions of Vehicular Technology, Vol. 43, No. 3, 8/94, incorporated fully herein by reference, which performed measurements specifically in the PCS 1.8 to 1.9 GHz frequency band. Xia found corresponding but more variable outcome results in San Francisco, Oakland (urban) and the Sunset and Mission Districts (suburban).

Please amend the paragraph at page 11, lines 12-16 as follows:

Yet another objective is to provide a low cost location system and method, adaptable to wireless telephony systems, for using simultaneously a plurality of base stations owned and/or operated by competing commercial mobile radio service providers within a common radio coverage area, in order to achieve FCC phase 2 or other accuracy requirements, and for synergistically increasing mobile station location accuracy and consistency.

Please amend the paragraph at page 11, lines 17-23 as follows (see Remarks regarding this amendment):

Yet another objective is to provide a low cost location system and method, adaptable to wireless telephony systems, for using a plurality of location techniques In particular, at least some of the following mobile station location techniques can be utilized by various embodiments of the present invention:

~~* time-of-arrival wireless signal processing techniques;~~

~~* time-difference-of-arrival wireless signal processing techniques;~~

~~* wireless signal processing techniques.~~

(4.1) time-of-arrival wireless signal processing techniques;

(4.2) time-difference-of-arrival wireless signal processing techniques;

(4.3) adaptive wireless signal processing techniques having, for example, learning capabilities and including, for instance, neural net and genetic algorithm processing;

(4.4) signal processing techniques for matching MS location signals with wireless signal characteristics of known areas;

(4.5) conflict resolution techniques for resolving conflicts in hypotheses for MS location estimates;

(4.6) enhancement of MS location estimates through the use of both heuristics and historical data associating MS wireless signal characteristics with known locations and/or environmental conditions.

Please amend the paragraph at page 16, lines 5-8 as follows:

(3.) providing the resultant location estimation characteristic values to a mobile station location estimate ~~module~~ model, wherein each such model (also denoted a "first order model" or FOM) subsequently determines the estimate of the location of the target mobile station based on, for example, the signal processing techniques (1.) through (2.) above.

Please add the following text at page 17, line 6 (see Remarks regarding this amendment):

For example, in one embodiment, the present invention includes low cost, low power base stations, denoted location base stations (LBS) above, providing, for example, CDMA pilot channels to a very limited area about each such LBS. The location base stations may provide limited voice traffic capabilities, but each is capable of gathering sufficient wireless signal characteristics from an MS within the location base station's range to facilitate locating the MS. Thus, by positioning the location base stations at known locations in a geographic region such as, for instance, on street lamp poles and road signs, additional MS location accuracy can be obtained. That is, due to the low power signal output by such location base stations, for there to be communication between a location base station and a target MS, the MS must be relatively near the location base station. Additionally, for each location base station not in communication with the target MS, it is likely that the MS is not near to this location base station. Thus, by utilizing information received from both location base stations in communication with the target MS and those that are not in communication with the target MS, the present invention can substantially narrow the possible geographic areas within which the target MS is likely to be. Further, by providing each location base station (LBS) with a co-located stationary wireless transceiver (denoted a built-in MS above) having similar functionality to an MS, the following advantages are provided:

(4.1) assuming that the co-located base station capabilities and the stationary transceiver of an LBS are such that the base station capabilities and the stationary transceiver communicate with one another, the stationary transceiver can be signaled by another component(s) of the present invention to activate or deactivate its associated base station capability, thereby conserving power for the LBS that operate on a restricted power such as solar electrical power;

(4.2) the stationary transceiver of an LBS can be used for transferring target MS location information obtained by the LBS to a conventional telephony base station;

(4.3) since the location of each LBS is known and can be used in location processing, the present invention is able to (re)train and/or (re)calibrate itself in geographical areas having such LBSs. That is, by activating each LBS stationary transceiver so that there is signal communication between the stationary transceiver and surrounding base stations within range, wireless signal characteristic values for the location of the stationary transceiver are obtained for each such base station.

Please amend the paragraph beginning at page 20, line 22 and ending at page 21, line 1 as follows:

Another embodiment of the present invention includes providing the location of a plurality of mobile stations using the public Internet or an intranet, with either having the ability to further use "push", or "netcasting" technology. This embodiment provides location information to either the initiating Internet[[/]] <u>or</u> Intranet user who wishes to learn of one or more mobile station locations, using either the Internet or an intranet. Either the mobile station user to be located can initiate a request for the user to be located, or an Internet/intranet user may initiate the location request. Optionally the location information could be provided autonomously, or periodically, or in accordance with other logic criteria, to the recipient of the location information via the Internet or a intranet. As a further option, location information can be superimposed onto various maps (e.g., bit/raster, vector, digital photograph, etc.) for convenient display to the user.

Please <u>delete</u> the paragraph at page 38, lines 8-9 which reads as follows:

Aspect 92. An apparatus for locating a mobile station as in Aspect 3, further including a

means for providing a location estimate using the Internet.

Please amend the paragraph at page 38, lines 10-12 as follows:

Aspect 92 ~~93~~. An apparatus for locating a mobile station as in Aspect 3, further including a means for providing a location estimate using digital certificate keys and the Internet.

Please amend the paragraph at page 38, lines 13-14 as follows:

Aspect 93 ~~94~~. An apparatus for locating a mobile station as in Aspect 91, further including a means for providing a location estimate using push technology on the Internet.

Please amend the paragraph at page 38, lines 16-17 as follows:

~~Further features and advantages of the present invention are provided by the figures and detailed description accompanying this invention summary.~~ Further description of the advantages, benefits and patentable aspects of the present invention will become evident from the accompanying drawings and description hereinbelow. All novel aspects of the invention, whether mentioned explicitly in this Summary section or not, are considered subject matter for patent protection either singly or in combination with other aspects of the invention. Accordingly, such novel aspects of the present invention disclosed hereinbelow and/or in the drawings that may be omitted from, or less than fully described in, this Summary section are fully incorporated herein by reference into this Summary. In particular, all claims of the Claims section hereinbelow are fully incorporated herein by reference into this Summary section.

Please amend the paragraph beginning at page 42, line 42 and ending at page 43, line 4 as follows:

(1.2) a signal processing subsystem 20, which is in communication with the application programming interface (L-API) 14. The signal processor 20 receives, queues, filters and processes signal measurement messages into various formats suitable for the location estimate modules DA 10 and TOA/TDOA 8;

Please amend the paragraph beginning at page 45, line 30 and ending at page 46,

line 14 as follows:

Referring again to Fig. 2, the Location system 142 interfaces with the mobile switch center 112 either via dedicated transport facilities 178, using for example, any number of LAN/WAN technologies, such as Ethernet, fast Ethernet, frame relay, virtual private networks, etc., or via the PSTN 124 (not shown). The location system 142 receives autonomous (e.g., unsolicited) or command/response messages regarding, for example: (a) the wireless network states, including for example, the fact that a base station has been taken in or out of service, (b) mobile station 140 and BS 122 radio frequency (RF) signal measurements, (c) notifications from a SCP 104 indicating that an HBS 160 has detected and registered with the SCP 104 the mobile station 140 corresponding to the HBS 160, and (d) any distributed antenna systems 168. Conversely, the location system 142 provides data and control information to each of the above components in (a) - (~~c~~d). Additionally, the Location system 142 may provide location information to a mobile station 140, via a BS 122, using, for example the short message service protocol, or any data communication protocol supported by the air interface between the base station and the mobile station. Interface 106 connecting the location system 142 with the service control point 104 may also be required in the event the home location register and/or the home base station AIN function is located in the SCP 104.

Please amend the paragraph beginning at page 52, line 13 and ending at page 53, line 2 as follows:

Referring to Fig. 16, in one embodiment a software controllable data connection or path 49 is established between the control processor 46, and the user digital baseband 30 functional components in the mobile station, a much larger quantity of RF measurements, on the order of 128 data samples, can be transmitted as a data burst, multiplexed, or sent by other means such as a data circuit call, back to the network, and to the Location Center. Note that the existing connection between the control processor 534 and the transmit modulator 546 may also be used, as well via any other virtual path, such as software register-to-register move instructions, as long as sufficient signal measurement content and data samples can be sent to the wireless network and the location center 142 via the associated interfaces. Those skilled in the art will understand the wireless network consists of the base station, mobile switch center, and related infrastructure

equipment, interfaces and facilities circuits to telemeter the measurement content and data samples to the location center 142. Additional design issues include, for example, the fact that existing memory in the mobile station must be allocated to the temporary storage of RF sample measurements, and new control means, such as selecting a future use control bit pattern in the CDMA air standard, are required to telemeter, preferably upon command, RF measurement sample data to the Location Center 142 in Fig. 1. In the case where a location request is received by the location engine 139 in the location center 142, the location engine 139 initiates a message to the mobile station 140 via a signal processing subsystem and the location center mobile switch center physical interface, the location applications programming interface 136 <u>(e.g., Fig. 36, L-API-MSC)</u> for the mobile switch center 112 and the wireless network infrastructure.

Please enter the following section heading immediately <u>before</u> the paragraph beginning at page 53, line 19 as follows:

<u>Network Data Services</u>

Please enter the following section heading immediately <u>before</u> the paragraph beginning at page 56, line 20 as follows:

<u>Fuzzy Logic For Vertical Location</u>

Please amend the paragraph at page 58, lines 4-16 as follows:

A location application programming interface 14 (Fig. 1), or L-API, is required between the location system's 142 signal processor 20 and the mobile switch center 12 network element type, in order to send and receive various control, signals and data messages for wireless location purposes. The L-API 14 is implemented using a preferably high-capacity physical layer communications interface, such as IEEE standard 802.3 (10 baseT Ethernet), although other physical layer interfaces could be used, such as fiber optic ATM, frame relay, etc. Two forms of API implementation are possible. In the first case the <u>control</u> signals ~~control~~ and data messages are realized using the mobile switch center 112 vendor's native operations messages inherent in the product offering, without any special modifications. In the second case the L-API 14 includes a full suite of commands and messaging content specifically optimized for wireless location purposes, which may require some, although minor development on the part of the mobile switch

center vendor. A minimum set of L-API message types includes:

Please amend the paragraph at page 58, lines 17-22 as follows:

A first message type, an autonomous notification message from the mobile switch center 112 to the location system 142, is required in the event a wireless enhanced 9-1-1 call has been sent to the mobile switch center from a[[n]] mobile station 140, including the mobile identification number (MIN), along with various CMRS identification and mobile station detected active, candidate, neighbor and remaining pilot set information, pilot strength measurements message.

Please amend the paragraph at page 60, lines 1-24 as follows:

A sixth message type, an autonomous notification message type issued from the location system 142 to the home location register, is required for those location applications that rely on an alert from the home location register when ever a particular mobile station state change occurs, along with various CMRS identification. Consider the case wherein an mobile station 140 whose location is to be tracked constantly. In such cases a history of locations is maintained in the location system 142. Should the mobile station 140 user turn off the power, or exit from the coverage area, then by using previous location values a vector and approximate velocity can be determined. This sixth message type provides a notification message from the home location register to the location system 142 whenever a previously identified mobile station MIN has a state change. Examples of state changes include cases where the base station 122 discovers the mobile station 140 has traveled to another base station, or that the current primary base station 122 can no longer communicate with the mobile station 140 (i.e., no power), or that a new registration has occurred. In general this message type should support the notification from the home location register to the location system 142 of all messaging and data associated with the nine types of registration, in the case of CDMA. Specifically these include power-up, power-down, timer-based, distance-based, zone-based, parameter-change, ordered, implicit and traffic channel registration. The location system 142 should also be informed of the registration enablement status of each type of registration, which can be provided to the location system 142 via a redirection of the systems parameters message. It should also be possible (in a[[n]] seventh message type) for the location system 142 to initiate an ordered registration through an order

message, from the location system 142 to the mobile switch center 112. The mobile switch center 112 then shall route the message to the appropriate base station, and then to the mobile station. The location system 142 should also be able to receive the results of the message.

Please amend the paragraph beginning at page 60, line 25 and ending at page 61, line 6 as follows:

In order to implement additional location functions such as providing users with location information and routing instructions to certain locations via the wireless short message text paging service, an L-API 14 is required between the location system 142 and the network element type used to implement the short message service. Such network elements may be termed an intelligent peripheral or a service node. A number of existing paging interfaces have been proposed in standards bodies, and one or more modifications can be made to accommodate L-API 14 content. In any case, the following L-API addition is required: an eighth message type which allows the location system 142 to send a text message containing location information or instructions to a particular mobile station MIN, and a related message to verify response. Optionally in another, ninth message type, an autonomous message may be provided to alert the location system 142 under conditions wherein a state change occurs on a previously pending text message. This last message type provides improved quality feedback to the initiating party regarding the acceptance situation of the attempted-to-send page.

Please amend the paragraph at page 62, lines 20-30 as follows (see Remarks regarding this amendment):

If appropriate, a variation of the above process includes a location center initiated forced hard hand-off of the mobile station from a primary base station, e.g., 122b associated with CMRS-A, to a new primary base station associated with CMRS-B, e.g., 122d. A forced hand-off will further provide improvements in reducing systemic timing errors which may be inherent among base stations owned by different CMRS. After the appropriate signal measurements have been reported the location system 142 can revert the hand-off back to the original CMRS. Other location system components shown in Fig. 3 includ~~es the controller~~ the L-API 14 ~~for the~~ which includes the location applications programming interface 136 (L-API-MSC) ~~14 for~~ as a

communications interface with multiple CMRS mobile switching centers, via physical interfaces 176a and 176b ~~(this portion of the controller and the location application programming interface is also denoted herein as L_API_MSC 136, see Figs. 36, 42)~~.

Please amend the paragraph beginning at page 62, line 31 and ending at page 63, line 12 as follows:

In order to provide the most economically efficient and accurate wireless location service capabilities among multiple CMRS providers in a shared coverage area, a common location applications programming interface (L-API 14) is highly desirable. A common interface also supports the natural competitive behaviors among wireless consumers and CMRS by providing flexible relationships among consumers who may want to switch service providers, yet retain consistent wireless location services for public safety. This approach minimizes the L-API design and deployment costs among infrastructure vendors and location service providers in a shared coverage area. Based on a L-API between a wireless location center and the mobile switch centers of multiple CMRS, a novel aspect of this invention further includes a method and process that provides account management clearing house and revenue settlement capability with appropriate security management controls. This capability is implemented as wireless location control, accounting and security mediation agent functions to compensate CMRS providers for providing various location-specific network services as described herein.

Please amend the paragraph at page 63, lines 13-23 as follows:

As wireless location requests are sent to the location center for a given CMRS, operated by a wireless location service provider (WLSP), the location center: 1.) assesses the appropriateness of soliciting additional signal and control measurements from another CMRS' base station in the same coverage area, in order to improve the quality of the location estimate, 2.) ~~Accesses~~ accesses, requests and receives signal and control information with another CMRS base station infrastructure, 3.) provides as appropriate a record of compensation entitlement between or among multiple CRMS and WLSPs, and 4.) provides security management controls that protect the privacy needs of wireless customers and the unauthorized sharing of information between or among CMRS. Security controls also include audit trails and controls regarding customer access of their location subscriber profile and the administration of network security

processes and related base station parameters and inventory.

Please amend the paragraph beginning at page 63, line 24 and ending at page 64, line 1 as follows (see Remarks regarding this amendment):

Referring to Fig. 5, Location Center-base station access, multiple CMRS, an alternative embodiment is provided to extract the wireless location signal measurement data from each base station associated with each of multiple CMRS. Given base station 122i and 122j are operated by CMRS-A and base station 122k and 122m are operated by CMRS-B, a communication circuit provides connectivity with the location application programming interface - base station (L-API-BS) ~~109~~ (not shown). The L-API-BS ~~109~~ is in communication with the L-API 14 ~~controller 15 (Fig. 29)~~ in the location center 142. The communications circuit can be any of several conventional transport facilities, such as a private line circuit, a DS-1 or T-1 carrier circuit, frame relay circuit, microwave circuit, or other data communications circuit.

Please amend the paragraph beginning at page 64, line 22 and ending at page 65, line 1 as follows:

When a mobile station (MS) is near the HBSD as shown in Fig. 17, and the HBSD detects the presence of a mobile station over the ~~Cordless~~ cordless phone air interface, the HBSD signals the Home Location Register (HLR) software in the Service Control Point in the AIN network associated with the mobile station and mobile station's home mobile switch center. The home location register redirects mobile station terminating calls from the network away form the mobile station's mobile identification number in the mobile switch center, and to the AIN/SSP wireline class V switch which connects the wireline number associated with the HBSD. Similarly, the HBSD, upon detecting a mobile station call origination attempt, redirects the mobile station signal from a PCS network fixed base station, to the control of the HBSD. The HBSD redirects the mobile station originating call through the wireline network, similar to any other wireline network call.

Please amend the paragraph at page 70, lines 11-19 as follows:

Note that the measurements may be averaged over a sample space of 128 individual measurements. Referring now back to Fig. 14, it can be seen that the first finger is associated

with the DA cell-1, range 0 to 1.96 microseconds, and DA cell-2, range 2.46 microseconds to 4.42 microseconds (uS), and DA cell-4, range 7.38 to 9.34 microseconds. Since the DA cell antennas are fixed, with known locations, correlation's can be derived and established to relate actual measurements with locations. Any one of several location estimating models ~~estimate modules~~ may be used, ~~as shown in Fig. DA-12: Location Estimate~~ using the radius-radius method, or multiple invocations of different modules may alternatively be used to form a location estimate of the mobile station within the DA environment.

Please amend the paragraph at page 70, lines 20-25 as follows:

It is now possible to classify the above actual measurements as propagation delayed signals for the DA cells 1, 2, and 4, since each DA cell delay range is known, and sufficient guard zones exist between delay spread ranges to unambiguously classify the measurements, and thus to determine mobile station location. The following table illustrates a typical database containing the classification columns for each DA cell and their corresponding location in an x,y plane.

Please amend the paragraph beginning at page 74, line 12 and ending at page 75, line 4 as follows:

The ~~following diagrams~~ Figs. 18 and 19 illustrate a certain case from a location measurement perspective, of signals received for a three-data receiver and a four-data receiver configuration, in a nominal three sector honeycomb base station configuration. In Fig. 18, a mobile station at location "A" detects base stations 1b, 5c, and 4a. However although a triad of signals are received, if varying multipath signals are received from one or more base stations, then ambiguity can still result. Fig. 19 illustrates a mobile station located at position "A", detecting base stations 1b, 5c, 4a, and 2c. Although additional information is made available in this second case, traditional hyperbolic combinations taken three at a time, yield multiple location estimates. In certain cases the limit of the back-side of a "far-away" sectored antenna can be used to determine the limit of RF coverage in another base station sector area. Fig. 20 shows that normally a delay spread in sector 1b would imply a range of a 120 degree solid angle. However by using the known fact that base station sector 2a contains a coverage limit, such negative logic can be used to further restrict the apparent coverage area in sector 1b, from 120

degrees to approximately 90 degrees as shown in the illustration, in order to locate the mobile station B. Such information regarding sector 2a can be determined by collecting the remaining set information from mobile station B.

Please amend the paragraph at page 75, lines 5-13 as follows:

Now consider more practical, less ideal cases. Due to the large capital outlay costs associated with providing three or more overlapping base station coverage signals in every possible location, most practical digital PCS deployments result in fewer than three base station pilot channels being reportable in the majority of location areas, thus resulting in a larger, more amorphous location estimate. Fig. 20 and 21 illustrate a typical relative error space wherein a mobile station detects only two base station pilot channels, and only one pilot channel, respectively. This consequence requires a family of location estimate location modules or models, each firing whenever suitable data has been presented to a model, thus providing a location estimate to a backend subsystem which resolves ambiguities.

Please amend the paragraph at page 81, lines 9-20 as follows:

Input ~~queues~~ queue(s) 7 are required in order to stage the rapid acceptance of a significant amount of RF signal measurement data, used for either location estimate purposes or to accept autonomous location data. Each location request using fixed base stations may, in one embodiment, contain from 1 to 128 radio frequency measurements from the mobile station, which translates to approximately 61.44 kilobytes of signal measurement data to be collected within 10 seconds and 128 measurements from each of possibly four base stations, or 245.76 kilobytes for all base stations, for a total of approximately 640 signal measurements from the five sources, or 307.2 kilobytes to arrive per mobile station location request in 10 seconds. An input queue storage space is assigned at the moment a location request begins, in order to establish a formatted data structure in persistent store. Depending upon the urgency of the time required to render a location estimate, fewer or more signal measurement samples can be taken and stored in the input queue(s) 7 accordingly.

Please amend the paragraph beginning at page 82, line 25 and ending at page 83, line 16 as follows:

In addition the controller 15 receives autonomous messages from the MSC , via the location applications programming interface 14 (Fig. 1) or L-API and the input queue 7, whenever a 9-1-1 wireless call is originated. The mobile switch center provides this autonomous notification to the location system as follows: By specifying the appropriate mobile switch center operations and maintenance commands to surveil calls based on certain digits dialed such as 9-1-1, the location applications programming interface 14 (Fig. 1), in communication[[s]] with the MSC 112a and/or 112b in Fig.1, receives an autonomous notification whenever a mobile station user dials 9-1-1. Specifically, a bi-directional authorized communications port is configured, usually at the operations and maintenance subsystem of the MSC 112a and/or 112b in Fig. 1, or with their associated network element manager system(s), with a data circuit, such as a DS-1, with the location applications programming interface 14 in Fig. 1. Next, the "call trace" capability of the mobile switch center is activated for the respective communications port. The exact implementation of the vendor-specific man-machine or Open Systems Interface (OSI) commands(s) and their associated data structures generally vary among MSC vendors, however the trace function is generally available in various forms, and is required in order to comply with Federal Bureau of Investigation authorities for wire tap purposes. After the appropriate surveillance commands are established on the MSC, such 9-1-1 call notifications messages containing the mobile station identification number (MIN) and, in FCC phase 1 E9-1-1 implementations, a pseudo-automatic number identification (a.k.a. pANI) which provides an association with the primary base station in which the 9-1-1 caller is in communication, are communicated. In cases where the pANI is known from the onset, the signal processing subsystem 20 avoids querying the MSC in question to determine the primary base station identification associated with the 9-1-1 mobile station caller.

Please amend the paragraph beginning at page 83, line 31 and ending at page 84, line 18 as follows:

Having determined a likely set of base stations which may both detect the mobile station's transmitter signal, as well as to determine the set of likely pilot channels (i.e., base stations and their associated physical antenna sectors) detectable by the mobile station in the area surrounding the primary base station (sector), the controller 15 initiates messages to both the mobile station and appropriate base stations (sectors) to perform signal measurements and to

return the results of such measurements to the signal processing system regarding the mobile station to be located. This step may be accomplished via several interface means. In a first case the controller 15 utilizes, for a given MSC, predetermined storage information in the MSC table 31 to determine which type of commands, such as man-machine or OSI commands are needed to request such signal measurements for a given MSC 112a or 112b in Fig. 1. The controller generates the mobile and base station signal measurement commands appropriate for the MSC and passes the commands via the input queue 7 and the locations application programming interface 14 in Fig.1, to the appropriate MSC 112a and 112b, using the authorized communications port mentioned earlier. In a second case the controller 15 communicates directly with the base stations as discussed above and shown in Fig. 5, Location Center-base station access, multiple CMRS. In this second case, an alternative embodiment is provided to directly extract the wireless location signal measurement data from each base station associated with each of the multiple CMRS networks having to interface directly with the MSC for signal measurement extraction.

Please amend the paragraph beginning at page 84, line 19 and ending at page 85, line 2 as follows:

Upon receipt of the signal measurements, the signal classifier 9 examines location application programming interface-provided message header information from the source of the location measurement (for example, from a fixed BS 122, a mobile station 140, a distributed antenna system 168 or message location data related to a home base station), provided by the location applications programming interface (L-API 14) via the input queue 7 and determines whether or not device filters 17 or image filters 19 are needed, and assesses a relative priority in processing, such as an emergency versus a background location task, in terms of grouping like data associated with a given location request. In the case where multiple signal measurement requests are outstanding for various base stations, some of which may be associated with a different CMRS network, an additional signal classifier function includes sorting and associating the appropriate incoming signal measurements together such that the digital signal processor 17 processes related measurements in order to build ensemble data sets. Such ensembles allow for a variety of functions such as averaging, outlier removal over a time period, and related filtering functions, and further prevent association errors from occurring in location estimate processing.

Please amend the paragraph beginning at page 116, line 28 and ending at page 118, line 10 as follows:

Referring to Fig. 36, a user (the initiating caller) desiring the location of a target mobile station 140a, such as a user at a telephone station 162 which is in communication with a tandem switch 489 or a user of an mobile station 140b, or any other telephone station user, such as a computer program, dials a publicly dialable telephone number which terminates on the automatic call distributor 546 (ACD), associated with the location center 142. If the caller originated the call from [[an]] a mobile station ~~102~~ 140b, then the call is processed via a base station 122b to a mobile switch center 112a. The mobile switch center 112a recognizes that the call is to be routed to the PSTN 124 via an interoffice trunk interface 600. The PSTN 124 completes the call to the ACD 546, via a trunk group interface 500. Note that the initiating caller could access the ACD 546 in any number of ways, including various Inter-LATA Carriers 492, via the public switched telephone network (PSTN) 124. The ACD 546 includes a plurality of telephone network interface cards 508 which provide telephony channel associated signaling functions, such as pulse dialing and detection, automatic number identification, winking, flash, off-hook voice synthesized answer, dual tone multi frequency (DTMF) detection, system intercept tones (i.e., busy, no-answer, out-of-service), disconnected, call progress, answer machine detection, text-to-speech and automatic speech recognition. Note that some of these functions may be implemented with associated digital signal processing cards connected to the network cards via an internal bus system. An assigned telephone network interface card 508 detects the incoming call, provides an off-hook (answer signal) to the calling party, then provides a text to speech (TTS) message, via an assigned text-to-speech card 512 indicating the nature of the call to the user, collects the automatic number identification information if available (or optionally prompts the caller for this information), then proceeds to collect the mobile identification number (MIN) to be located. MIN collection, which is provided by the initiating caller through keypad signaling tones, can be achieved in several methods. In one case the network card 508 can request a TTS message via text-to-speech card 512, which prompts the initiator to key in the MIN number by keypad DTMF signals, or an automatic speech recognition system can be used to collect the MIN digits. After the MIN digits have been collected, a location request message is sent to a location application 146. The location application 146, in concert with location application interface 14 (more

particularly, L-API-Loc 135, see Fig. ~~35~~ 36), in the location system 142, is in communication with the location engine 139. Note that the location engine 139 includes the signal processing subsystem 20, and one or more location estimate modules, i.e., DA module 10, TOA/TDOA module 8 or HBS module 6. The location engine 139 initiates a series of messages, using the location application programming interface (L-API-MSC 136) to the mobile switch center 112a ~~station 140~~. The location application programming interface 136 then communicates with one or more mobile switch centers [[108]] 112b, to determine whether or not the mobile station 140a to be located can be located. Conditions ~~regarding~~ affecting the locateability of [[an]] the mobile station 140a include, for example: the mobile station 140a being powered off, the mobile station 140a not being in communication range, the mobile station 140a roaming state not being known, the mobile station 140a not being provisioned for service, and related conditions. If the mobile station 140a cannot be located then an appropriate error response message is provided to the initiating caller, via e-mail, using the web server 464 in communications with the Internet 468 via an Internet access channel 472 or alternatively the error response message may be sent to a text to speech card 512, which is in communications with the initiating caller via the telephone interface card 508 and the ACD 546, which is in communication via telephony interface circuits 500 to the PSTN 124.

Please amend the paragraph at page 118, lines 11-16 as follows:

Note that in cases where rendering location estimate information is required on the Internet, the web server 464 can include the provision of a digital certificate key, thus enabling a secure, encrypted communication channel between the location web server 464 and the receiving client. One such digital encryption key capability is a web server provided by Netscape Communications, Inc. and a digital certificate key provided by Verisign, Inc. both located in the state of California, U.S.A.

Please amend the paragraph at page 118, lines 17-28 as follows:

The PSTN 124 completes routing of the response message to the initiating caller via routine telephony principles, as one skilled in the art will understand. Otherwise the mobile station 140a is located using methods described in greater detail elsewhere herein. At a high level, the mobile switch center 112a is in communication with the appropriate base stations 122,

and provides the location system 142 with the necessary signal and data results to enable a location estimation to be performed by the location engine 139. Once the location has been determined by the location engine 139 in terms of Latitude, Longitude and optionally height if known (in the form of a text string), the result is provided by to the initiator by inputting the location text string to a text-to-speech card 512, which in turn is in communication with the assigned telephone interface card 508, via the automatic control distributor 546, for completing ~~completes~~ the communication path and providing the location response back to the initiating user via the telephone interface 500 to the PSTN 124, and from the PSTN 124 to the initiating user.

Please amend the paragraph beginning at page 118, line 29 and ending at page 119, line 13 as follows:

Alternatively the location results from the location application 146 (e.g., Figs. 37 and 38) could be provided to the initiating caller or Internet user via a web server 464 in communication with the Internet 468, via an Internet access channel 472 and a firewall 474 (e.g., Fig. 36). In another embodiment, the location results determined by the location application 146 may be presented in terms of street addresses, neighborhood areas, building names, and related means familiar to human users. The alternative location result can be achieved by previously storing a relationship between location descriptors familiar to humans and Latitude and Longitude range values in a map database 538 (Fig. 36). During the location request, the location application 146 accesses the map database 538, providing it with the Latitude and Longitude information in the form of a primary key which is then used to retrieve the location descriptor familiar to humans. Note that to those skilled in the art, the map database 538 and associated messaging between the map database 538 and the location application 146 can be implemented in any number of techniques. A straightforward approach includes defining a logical and physical data model using a relational database and designer environment, such as "ORACLE 2000" for the design and development, using a relational database, such as the "ORACLE 7.3" database.

Please amend the paragraph at page 119, lines 14-15 as follows:

In an alternative embodiment, the location application 146 may be internal to the location system 142 (e.g. Fig. 37), as one skilled in the art will understand.

Please amend the paragraph beginning at page 126, line 31 and ending at page 128, line 3 as follows (see Remarks regarding this amendment):

Referring to Fig. 42, a vehicle 578 containing various sensors and actuators (not shown) used to, for example, lock and unlock car doors, sense door position, keypad depressions, sense the condition of the engine and various subsystems, such as brakes, electrical subsystems, sense the amount of various fluid levels, etc., is in communication with a vehicle-based local area network 572, which is in turn connected to a mobile station 140 containing asynchronous data communications capability. The vehicle-based local area network may optionally contain a computer (not shown) for control and interfacing functions. The mobile station 140 is always in communication, using the radio air interface with at least one base station 122g, and possibly other base stations 122h. The base stations 122g and 122h are in communication with the mobile switch center 112 via transport facilities 176. The mobile switch center 112 is in communication with the location system 142 and the public switched telephone network 124 via interoffice trunks 600. In addition the mobile switch center 112 is also in communication with the location system 142 via the location system - mobile switch center physical interface 178. The physical interface provides two-way connections to the location applications programming interface (i.e., L-API-MSC 136), which is in communication with a location engine 139, which performs wireless location estimations for the mobile station, which is permanently mounted in the vehicle 578. The location engine 139 represents key components within the location system 142 which together comprise the capability to perform wireless location estimations. The rental car location application 146 is in communications with the location engine 139 for purposes of initiating wireless location requests regarding the mobile station 140, as well as for receiving wireless location responses from the location engine 139. The application 146 is in communications with the automatic call distributor 546 for purposes of initiating and receiving telephone calls to and from the public switch telephone network 124, via hunt group interface 500. As one skilled in the art will appreciate, other interfaces (not shown) beyond hunt groups 500, can alternatively be used, such as ISDN interface circuits, T-carrier and the like. The application 146 is in communication with a web server and client 464, which in turn is in communication with the Internet 468 via an Internet access interface 472. As those in the art will understand, an Internet access interface is typically provided by an Internet service provider, also there are other

methods which could be used to complete the Internet connection. The rental car agency contains a workstation or personal computer 582 with an Internet access interface 472 to the Internet 468. The application 146 requests of the location engine 139 to perform a location request periodically regarding the mobile station 140, with the location response information provided the web server and client, 464. For each rental car or vehicle containing a mobile station 140, the location, as well as various information about the rental car or vehicle can be ascertained via the above described infrastructure.